

## IF08: Noble Elements

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# Noble Element detectors

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## Science

- ➔ Neutrino oscillation and interactions
- ➔ Neutrinoless double beta decay searches
- ➔ Dark Matter searches
- ➔ Collider physics

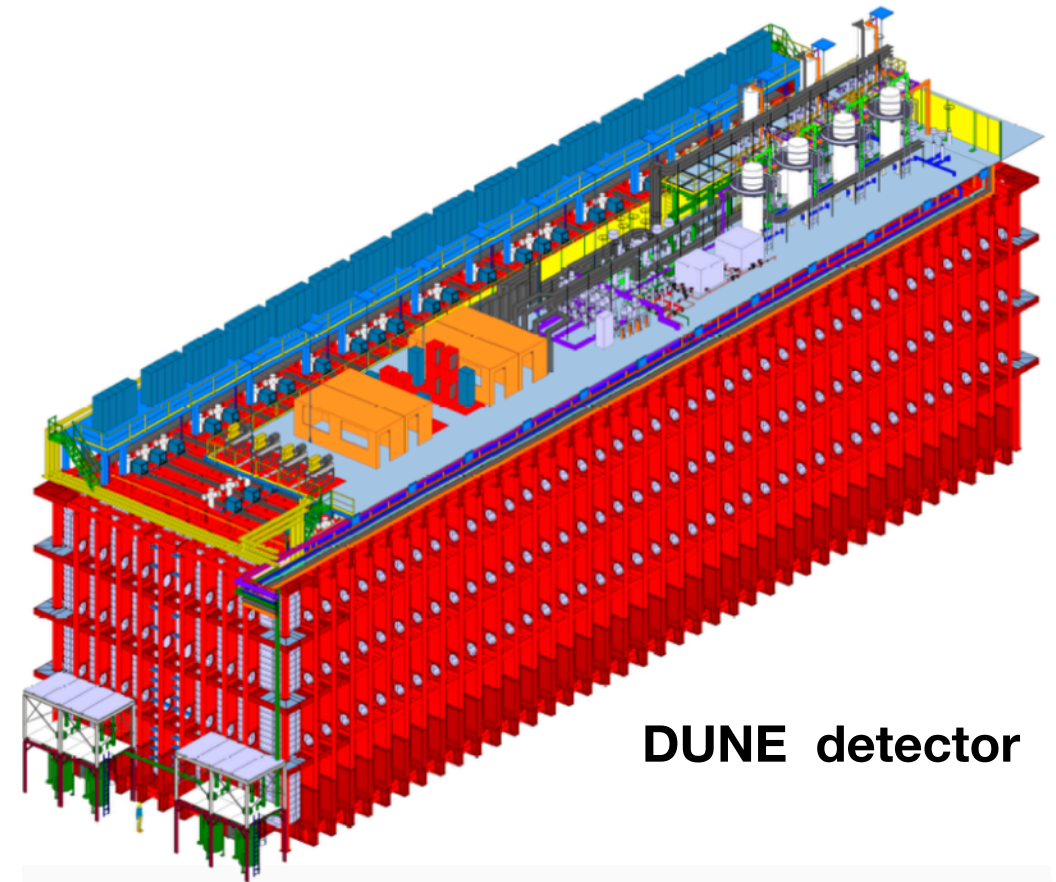
## Technology

- ➔ Liquid Argon
- ➔ Gaseous Argon
- ➔ Liquid Xenon
- ➔ Gaseous Xenon
- ➔ Single-phase/Dual phase TPCs
- ➔ Liquid Helium
- ➔ Other use of noble element (scintillating bubble chambers)
- ➔ Calorimeters

# Wide range of energy and of physics needs

- **DUNE:**

- ✓ Very large scale (40kt)
- ✓ Main goal is GeV  $\nu$ s
- ✓ MeV supernova  $\nu$ s
- ✓ Mainly charge readout, with small light detection coverage



**DUNE detector**

- **Dark Matter:**

- ✓ Large scale (multi-ton)
- ✓ Energy range from keV to MeV
- ✓ Very low background
- ✓ Mostly light readout (S1,S2)



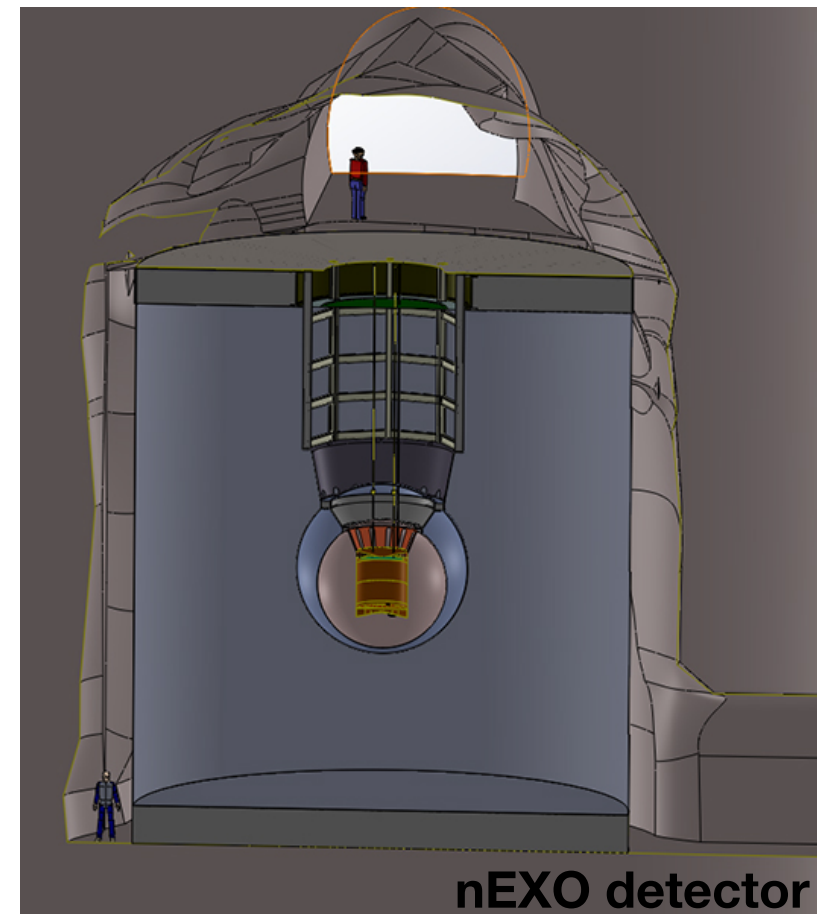
**XENON1T detector**



# Wide range of energy and of physics needs

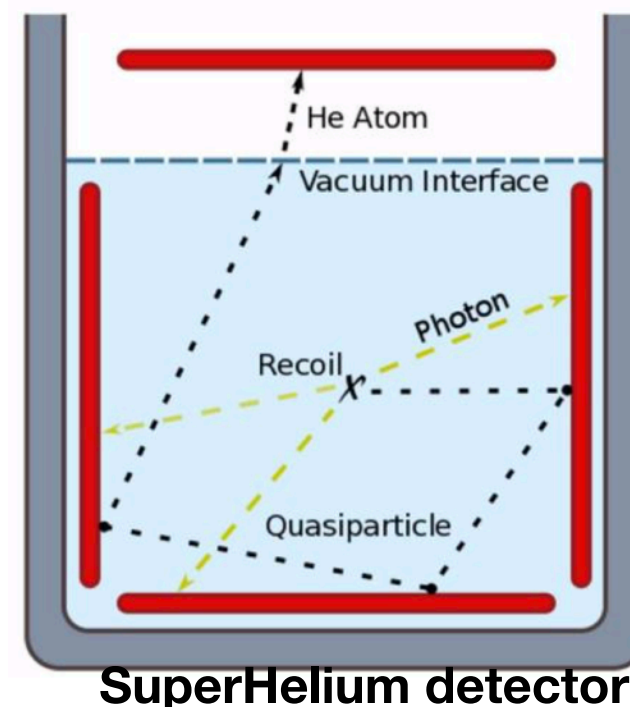
- **$0\nu\beta\beta$ :**

- ✓ Large scale (ton-scale)
- ✓ 2.5MeV electrons
- ✓ Extremely low backgrounds
- ✓ Charge and light readout, with ~high light detection coverage



- **Other types (e.g. LHe)**

- ✓ Small scale
- ✓ Very low energy (~sub-keV)
- ✓ Multimodal detection (light, phonons, rotons)
- ✓ Use quantum sensors



# What is covered in IF08

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- Our group represents Noble Element Detectors
- We will focus on the technology/instrumentation side of the topic, as the science focus is covered in the science groups
- Some overlap with other instrumentation groups (e.g. photon detectors, quantum sensors)
- Note some discussions regarding “orphan detector technology”: we will include non-noble phase change detectors, such as superheated bubble detectors and supercooled detectors (e.g. PICO and SNOWBALL)
- We would like the community to send us their input for instrumentation advancement of these detectors and we will coordinate with the science frontiers to ensure full coverage of the inputs
- We will start with input from CPAD and the *DOE Instrumentation Basics Research Needs* (BRN) study

# Examples of development needs

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- Increase and/or improve charge and light collection
- Develop and integrate new modes of detection (i.e. heat)
- Lower energy thresholds
- Improve the understanding and the calibration of microphysics
- Improve radiopurity (new/better material purification techniques) and improve assay methods
- Find new solutions for large-scale detectors (HV delivery, resistive materials, ...)

# Expected LOIs (not exhaustive list and no particular order)

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- ➔ 3D (pixel) readout for TPCs (LArPix, QPix,...)
- ➔ Ultra-low noise charge detector
- ➔ Single-electron sensitivity
- ➔ Signal amplification in liquid
- ➔ Integrated readout solutions for light and charge
- ➔ New and/or improved light detection devices
- ➔ New wavelength shifting methods (thin films, fluorescent and scintillating material, quantum dots, ...)
- ➔ New highly reflective materials
- ➔ Target mixture and medium doping
- ➔ Scintillating bubble chambers (Xe, Ar)
- ➔ Ion TPCs and ion tagging
- ➔ Novel detector structures and layouts
- ➔ Novel purity monitors
- ➔ Phonons and rotons (direct or indirect) detection
- ➔ Study of microphysics and calibration for charge, light and heat
- ➔ ...

# How to join us!

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- Email list: SNOWMASS-IF-08-NOBLE-ELEMENTS
- Slack Channel: #if08-noble\_elements
- Website: [https://snowmass21.org/instrumentation/noble\\_elements](https://snowmass21.org/instrumentation/noble_elements)
- Plans for the group in near future:
  - ➔ Build on top of the Instrumentation BRN effort
  - ➔ Continue to solicit LOIs from the community (**deadline 31 August 2020**)
  - ➔ SNOWMASS Planning meeting (**4-6 November 2020**)